

## **SECTION 16450 GROUNDING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawing and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Building ground grid.
  - 2. Structural grounding.
  - 3. Electrical equipment grounding.
  - 4. Non-electrical equipment grounding.

#### **1.3 REFERENCES**

- A. Institute of Electrical and Electronic Engineers (IEEE)
  - 1. IEEE 81-1991, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
  - 2. IEEE 80-2000, Guide for Safety in AC Substation Grounding.
- B. National Fire Protection Association (NFPA)
  - 1. NFPA 70-1999, National Electrical Code.

#### **1.4 SUBMITTALS**

- A. General: Submit each item in this Article according to the Conditions of the Contract and Supplementary Conditions.
- B. Products furnished from listed manufacturers are pre-approved but still require submittal.
- C. Submit proposed substitutions for approval in accordance with General and Supplementary Conditions.
- D. Submit approved test reports for information.

#### **1.5 QUALITY ASSURANCE**

- A. NFPA Compliance: Materials and components shall be fabricated and installed in compliance with NFPA 70.
- B. UL and NEMA Compliance: Provide materials that are listed and labeled by UL and comply with applicable NEMA standards.
- C. Listing and Labeling: Provide electrical components specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code (NEC), Article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulations 1910.7.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site in factory containers and in new condition. Keep conductive concrete stored in accordance with manufacturer's recommendations.

## 1.7 SEQUENCING AND SCHEDULING

- A. Coordinate location of grounding system components with respect to other systems and activities.

## 1.8 SYSTEM DESCRIPTION

- A. Provide ground connections required by NFPA 70.
- B. Minimum requirements of Article 250 of NFPA 70 apply where grounding conductor sizes are not indicated.
- C. Provide conductive concrete encased electrode where shown.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Ground Rods: Copperweld type, 3/4 in. diam, 10 ft long (min), Joslyn No. J8350.
- B. Connectors: Thermic type, Cadweld.
- C. Bonding: Thermic type, Cadweld.
- D. Conductors.
  - 1. Ground Mat, Electrical Safety System: No. 4/0 AWG, bare, stranded copper.
  - 2. Equipment Grounding Conductor.
    - a. Material: Bare or green insulated copper in steel or nonmetallic conduit; green insulated copper in aluminum conduit.
    - b. Size: As indicated.
    - c. Solid: No. 10 AWG and smaller.
    - d. Stranded: No. 8 AWG and larger.
- E. Encased Electrode: Portland Cement based concrete, with high carbon content to enhance conductivity, encased copper electrode.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify grounding system has been installed before making thermic bonding-type connections.
- B. Verify neutral bars in lighting and distribution panelboards are ungrounded.
- C. Excavate and prepare site for conductive concrete in accordance with manufacturer's recommendations.

### 3.2 INSTALLATION

- A. General
  - 1. Bond together system neutrals, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, and receptacle ground connectors, without creating ground loop.
- B. Ground Grid
  - 1. Install neutral grounding equipment according to manufacturer's instructions.
  - 2. Install ground mat according to IEEE 80.
  - 3. Install ground mat conductors 30 in. below grade.
  - 4. Make underground connections by thermic process.
  - 5. Do not install ground rods underneath sidewalks, roadway, or other locations which may become inaccessible.
- C. Structural Grounding
  - 1. Ground steel, ground busses, and ground inserts as indicated.
  - 2. Make connections of ground cables to structural members by thermic process.
  - 3. Terminate ground cables on ground busses with thermic process.
- D. Electrical Equipment Grounding
  - 1. Connect motor frames, panelboards, and enclosures housing electrical devices to building ground grid with an equipment grounding conductor.
  - 2. Install equipment grounding conductor in same conduit with current carrying conductors.
  - 3. Connect equipment grounding conductors to building ground grid at ground busses and ground inserts.
    - a. Grounding or bonding of equipment to building steel as a sole means of grounding is not acceptable.
    - b. Use of conduit as the equipment grounding conductor is not permitted.
  - 4. Make connections to ground busses and connections of equipment grounding conductors to switch boxes, panelboards, cabinets, and other similar equipment with either bolted mechanical lugs or compression connectors.
    - a. Before connections are made, clean contact surfaces.
    - b. Apply a compound to prevent oxidizing and ensure good electrical contact.
  - 5. Terminate branch circuit equipment ground conductors on lighting and distribution panelboard ground bus.
  - 6. Motor Grounding: Terminate equipment grounding conductor, either bare or insulated green, under one of the bolts holding the junction box to the motor frame.
    - a. Where junction box is welded in place or cast as part of frame, drill and tap junction box.
  - 7. Lighting Fixture Enclosure Grounding: Install a continuous ground conductor in same raceway as the circuit conductors and attach to metal enclosure of each lighting fixture and related local switch box.
  - 8. Receptacle Grounding: Connect receptacle grounding lug to the continuous ground conductor installed in same raceway as the circuit conductors and permanently bond ground conductor to building grounding system.
- E. Non-electrical Equipment: Ground non-electrical equipment, such as flammable liquid storage tanks, metal tanks, piping systems, major support structures, platforms, and supports according to applicable engineering standards.
- F. Encased Electrode: Provide length of trench as shown. Lay copper conductor shown in accordance with manufacturer's recommendations. Mix concrete and place in accordance with manufacturer's recommendations.

- G. Manhole Grounding:
  - 1. Install ground rod in floor of each manhole.
  - 2. Ground cable racks to manhole ground rod with #6 bare, solid, copper cable and exothermic connection.
  - 3. Bring exterior duct bank #4/0 bare copper cable into manhole and connect to ground rod in manhole floor.
  - 4. Ground circuit #4/0 copper cable in 5" conduit to exterior cable and manhole ground rod.

### 3.3 FIELD QUALITY CONTROL

- A. Test No. 1 - Individual Ground Rods and Single Run of Conductive Concrete.
  - 1. Before connection to ground mat, test each ground rod or encased electrode for resistance to earth using a Biddle Model "Megger DET 5/2".
  - 2. Utilize the "Three-Point-Method" described in IEEE Standard 81 and two auxiliary rods.
  - 3. Individual Ground Rod Resistance to Earth: Submit measured values.
  - 4. Encased electrode resistance to earth: 2 OHMS or less.
- B. Inspection No. 1 - Complete Ground Mat.
  - 1. After completion of Test No. 1, connect ground rods to ground mat.
  - 2. Before backfilling is done, visually inspect complete ground mat to ensure that connections are mechanically tight by the "Cadweld" or other approved process.
- C. Test No. 2 - Complete Ground Mat.
  - 1. Backfill after satisfactory visual inspection and test resistance of complete ground mat to earth using the "Fall-of-Potential Method" described in IEEE Standard 81.
  - 2. Acceptable Resistance for Complete Ground Mat: 1 ohm (max).
- D. Inspection No. 2 - Ground Straps.
  - 1. Visually inspect terminations of ground straps coming up from buried ground mat on ground busses and building steel for solidness of connections.
- E. Test No. 3 - Equipment Ground Busses.
  - 1. Test equipment ground busses in electrical equipment to ensure low resistance bolted connection between bus and equipment enclosure.
  - 2. Using a "Kelvin Bridge" between equipment ground bus and equipment enclosure. Observe and record ohmmeter readings.
  - 3. Acceptable Resistance: 0.01 ohm (max).
- F. Test No. 4 - Equipment Ground Conductors.
  - 1. Connect a "Kelvin Bridge" between equipment ground bus (to which equipment ground conductor is connected) and nearest building ground bus or ground strap connected directly to building ground grid.
  - 2. Record ohmmeter readings.
  - 3. Acceptable resistance: 0.1 ohm (max).

**END OF SECTION 16450**